11

Learning Industry Against Knowledge Economy? Lessons From the French Case

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11.1. INTRODUCTION

France frequently resists classification in international comparisons aimed at bringing out the features of developed economies. To paraphrase Stanley Hoffmann, it is the 'agony' of the researcher embarking on international comparisons. Thus, in terms of social welfare analysis, it long escaped Esping-Andersen's famous system—which led that author to prepare a special preface for the French edition of his book (1999). Similarly, in terms of institutionalist economics, it was so out of place in the New Political Economy's distinction between 'LMEs' and 'CMEs' (Hall and Soskice 2001) that it gave rise to a specific thesis intended to meet this analytical challenge (Hancké 2002).

We take this second approach as our point of departure because it is directly related to the subject of this book. The theoretical approach developed in Hall and Soskice's (2001) work on 'varieties of capitalism' opposes LMEs (predominantly Anglo-American) to CMEs. In the former, companies coordinate their activities mainly by relying on hierarchies and competitive devices in the context of the markets; educational systems give priority to general qualifications; and innovation dynamics tend to be radical rather than incremental. In the latter, companies are more likely to rely on non-market relations to coordinate their efforts with other players and build their main competences and they call upon vocational training systems which are specific to one industry or company. They tend to excel in generating incremental innovations (Germany and Japan in particular). Integrating France into this analytical scheme has led to a refinement of the original typology in so far as a distinction is now made between 'coordination at industry level' (Northern Europe), 'coordination at group level' (Japan), and 'coordination by public elite networks' (France).[1]

The objective here is not to produce an additional typology. Rather, we propose to examine France's international position in order to bring out the role of the higher education and research systems in the 'societal' dynamics of innovation.

The French situation is stimulating for analysis in two respects. First, higher education has undergone remarkable expansion since the early 1980s, and especially during the 1985–95 period. A determined public policy aimed at eliminating a considerable lag with respect to the other industrialized countries, and this was widely supported by the choices of young people and their families, as well as intermediary actors such as the regional councils, which were given broader powers in this area.

Second, following this apparently favourable period, a number of official reports emphasized the lack of efficiency of the higher education and research system. The research sector drew the most criticism (see the Guillaume report 1998) but the educational dimension was not exempt from harsh diagnoses (see the Attali report 1998). These reports gave rise to significant reforms: the 1999 law on innovation which was intended to forge new relations between higher education and industry; and the 2003 alignment of higher-education diplomas to the consecutive bachelors–masters–doctorate (B–M–D) system in accordance with the Bologna declaration of the European ministers of higher education and research.

In recent years, many criticisms have focused on the organizational features of the French education and research system and notably the two 'great divides' that characterize it: that between universities and major public research bodies such as the National Centre for Scientific Research (CNRS); and that between highly selective 'Grandes Ecoles' where students are closely supervised and the universities which are open to anyone holding a *baccalauréat* from the secondary system but which have limited means (expenditures per student are 40 per cent below the OECD average). We come back to these features which are obviously important. But the following paradox requires further consideration; the societal inadequacies of the higher education system have become patent at the same time as it has undergone exceptional development. This paradox is all the more interesting to examine because the changes have not simply been quantitative. In terms of university education, which generally receives the sharpest criticisms, we may cite the increasing vocational orientation of the curricula, and in terms of public research, which is often disparaged for its Byzantine administration, the increased recourse to contractual relations between universities and research bodies on the one hand, and between public laboratories and industry on the other. Such criticisms have called into question the effectiveness and political legitimacy of the higher education system, giving rise to demands for radical reforms.[2]

In what follows, we argue that the structural difficulties of the French higher education and research system are symptomatic of the 'societal' exhaustion or inadequacy of the two forms of industrial and institutional specialization which have dominated France's system of non-market coordination: *design-based flexible mass production*; and *high-tech complex engineering goods* (Hancké 2001). The first, which is relatively recent, results from the adjustments of the 1980s, while the second belongs to the classic lineage of an economy marked by the central role of the State. In both cases, education, training, and research play a key structuring role. We argue that it is not enough to expand and make more professional higher education and training; policies must also contribute to positioning the economy on favourable, lasting areas of industrial specializations. From this standpoint, it is not certain that the French model is sufficiently coherent.

11.2. OUTSTANDING DEVELOPMENT OF HIGHER EDUCATION: STRONG INCREASE OF EDUCATION LEVELS AND 'VOCATIONALIZATION'

In the context of this Chapter, it is more pertinent to focus on the higher training programmes which are most aligned with research and (potentially) innovation activities inside industries. In less than fifteen years, French higher education has undergone a spectacular development which in certain respects is unequalled among major OECD countries.

11.2.1 Rapid Rise in Education Levels Among the Younger Generations (1985–95)

The number of students rose from 1,181,000 in 1980–1 to 2,169,000 in 1995–6 followed by stagnation or a slight decrease. Since the mid-1990s, over 40 per cent of those existing the educational system (all levels combined) have been higher education graduates, while the proportion was barely 20 per cent at the beginning of the 1980s.

This is not the place to go into the basis for the rise of mass higher education in France, which was a complex result of voluntarist public policies and incentives arising from a macroeconomic context which made holding a higher level diploma an important advantage on the labour market (for an overview see Buechtemann and Verdier 1998). Table 11.1, taken from Vincens

Table 11.1 Generational structure by diploma[1]

Born in 1950				
Type of diploma	Germany	United Kingdom	France	Italy
1a	8	24	18	31
1b	14	—	18	—
2	2	12	7	34
3	53	38	30	5
4	—	4	10	20
5	21	22	17	10
Born in 1970				
Type of diploma	Germany	United Kingdom	France*	Italy
1a	8	11	17	6
1b	9	—	1	—
2	3	23	4	41
3	58	31	30	7
4	—	9	16	39
5	20	26	32	7

Notes: Employment survey 1999, thus at age 29, source EDEX.

1. Table 11.1 compares the generations born in 1950 and 1970 through the use of a simplified classification system proposed by Hilary Steedman. The categories are as follows:

- 1a. No diploma: in the UK; 'no qualifications'; in France, 'sans diplôme'; in Italy, 'primary school certificate or no diploma (not distinguished in data); in Germany, 'no diploma and no response'; in Spain, 'sense estudis'.
- 1b. Compulsory schooling completed and primary school certificate: in France, 'certificat d'études primaries', in Spain, 'primaries'; in Germany, 'Hauptschule'.
- 2. First-level secondary school certificate: in the UK, 'O levels', CSE and GSCE; in France, BEPC; in Germany, 'Realschule'; in Italy, 'scuola media' graduates; in Spain, 'Bachillerato elemental', EGB higher cycle.
- 3. Vocational training certificate: in the UK, 'others', including Trade Apprenticeship, City and Guilds, ONC/OND, NVQ 2/3; in France, CAP/BEP; in Germany, apprenticeships, BFS; in Italy, 'scuola professionale' graduates; in Spain, FP.
- 4. Second cycle secondary certificate (general, technical, or vocational) giving access to higher studies: in the UK, 'A Levels', in Germany, 'Abitur' and 'Fachhochschulreife; in France, 'baccalauréats'; in Italy, 'Maturita', 'Magisterio' and 'Scuola Technica' diplomas; in Spain, Bachillerato Superior, BUP, COU.
- 5. Higher education: in the UK, 'degrees', HNC/HND, teaching and nursing diplomas; in France, 'licences' and above, Bac+2 diplomas; in Germany, university diplomas, Meister and Techniciens; in Italy, university diplomas; in Spain, short and full university diplomas.

(2001), offers a good inter-generational and comparative perspective on the scope of the ongoing societal transformations which are introducing the human resource bases for a 'knowledge society'. The figures point to the relatively rapid increase in the importance of higher level education in France.

11.2.2. Sharp Increase in Flows from Technical Colleges, Engineering Schools, and University Science Programmes

Table 11.2 shows that the university's share of the total number of students declines during the period 1960–2002 in favour of the vocationally oriented training programmes within short-course higher education (two years after the *baccalauréat*): the polytechnics (Instituts Universitaires de Technologie [IUT], which are attached to the universities but enjoy considerable autonomy) and the Higher Technicien Sections (Sections de Techniciens Supérieur [STS], which are special college departments introduced in the high schools).[3]

In addition, within the growing numbers of university students, the vocational courses show a much greater increase than the general academic courses: on the average, the proportion of students in the former rose from 29 per cent of the total in 1996 to 36 per cent in 2002.[4] It must be emphasized that the training content—notably for the BTS and DUT[5]—is determined not unilaterally by the school administration but is subject to dialogue and negotiation with the occupational branches concerned, even if the role of the social partners is not as decisive as in Germany (Möbus and Verdier 2000).

As Table 11.3 shows, it is quite significant that during the most favourable period for the development of higher education (1984–95), the growth of the second and third cycles in the sciences was much more rapid than it was in the humanities and social sciences and economics as a whole, notwithstanding the fact that the latter were considerably less expensive and selective in terms of admission policies. The same is true, moreover, for the most selective programmes of all, namely the Grandes Ecoles. The number of engineering

Table 11.2 Numbers of higher education students and distribution by type of training body (in percentage)

Education and training providers	1960	1970	1980	1990	1995	2001	2003
University	69	75	68	65	64	60	59.7
IUT	—	2	4	4	5	5	5
STS	3	3	6	12	10	12	10.8
CPGE[1]	7	4	4	4	4	3	3.2
Other institutions	21	16	18	15	17	20	21.3
Total %	100	100	100	100	100	100	100
Total numbers (in 1,000s)	309.7	850.6	1174.9	1717.1	2140.9	2159.0	2256

Note: [1]Preparatory classes for 'Grandes Ecoles'.

Sources: Ministry of Education, Statistics for 2003 (MEN-DEP).

school graduates more than doubled (+150 per cent from 1984 to 1996) at a pace which was slightly greater and above all more regular than that of the business schools. The increase in the number of industrial vocational diplomas (BTS-DUT) was more limited, but it must be stressed that the expansion of this programme occurred earlier than that of full higher education (see Table 11.1).

There was thus a markedly orientation of the different higher education mechanisms towards the areas of science and technology. In a country marked by the considerable structural weight of the humanities and social sciences, this trend is worth emphasizing.[6] In 1996, for example, the flow of graduates from the second and third cycle science programmes represented nearly 30 per cent of the total number of graduates, as compared to 38 per cent in law and economics and 34 per cent in humanities and social sciences.

The success of these training programmes on the labour market clearly declined during the first half of the 1990s (as was the case for higher education graduates in general), given the double bind of slackening recruitment and a sharp rise in the number of graduates in the programmes concerned. Among the university programmes, it should be noted that the sciences held up better in terms of job level, as reflected in the proportion of managers with these qualifications. Graduates of the Grandes Ecoles continued to enjoy an especially favourable position on the labour market in spite of the doubling of their numbers in eight years. However, they were not the only ones

Table 11.3 Exists by specialization and diploma

	1988	1992	1996	96/88
Universities				
2nd + 3rd cycle sciences	9,424	17,768	34,260	264%
2nd + 3rd cycle law-economics	17,324	22,089	45,381	162%
2nd + 3rd cycle humanities/social sciences	14,729	22,458	40,296	174%
2nd + 3rd cycle total	41,477	62,315	119,937	189%
Grandes Ecoles				
Business schools	5,416	6,790	6,906	28%
Engineering schools	8,807	11,543	17,843	103%
Higher vocational education				
Vocational industry (DUT-BTS)	15,196	16,896	23,561	55%
Vocational services (DUT-BTS)	26,047	35,105	46,817	80%
Vocational total (DUT-BTS)	41,243	52,001	70,378	71%

Source: MEN-DPD, processing Céreq.

in this situation. Nearly 70 per cent of those with a DESS in a science field (professional diploma at bac+5 level) became engineers less than four years after they left university. This was also the case for half the graduates of professional university institutes [*instituts universitaires professionnalisés*] (bac+4).[7]

New reasons for concern about the future have emerged, however, stemming from a certain loss of interest in university science programmes among science *baccalauréat* holders since 1995. This trend is such that certain universities are trying to introduce reforms in order to stem the decline in the number of students enrolled in these studies (Péan 2001: 3).

Notwithstanding the evidence of a declining interest on the part of recent high school graduates for science studies, the attractiveness of vocationally oriented curricula shows no signs of wavering. By way of evidence we note:

1. The proven success of the DESS (professional masters) relative to the DEA (academic masters). Nearly 800 new DESS programmes were set up in three years (1999–2001), generating 15,000 additional places (between 1991 and 1999, the number of graduates annually had already increased from 14,000 to 29,000). This trend has been so pronounced that there is now a real risk of 'Balkanizing' training programmes and thus compromising the effectiveness of the labour market 'signals'. In the context of the B–M–D reform, an attempt at rationalization is underway through reorganization by subject matter.
2. The rapid growth of the vocational *licence* (the French equivalent of the bachelors) introduced from 1999, in spite of the reluctance of industrialists to recognize qualifications corresponding to three years of training after the *baccalauréat* (Maillard and Veneau 2003). In 2002–3, this diploma showed a 68 per cent increase, involving a total of 9,000 students in nearly 350 vocational *licence* programmes.

The overall equilibrium of the French educational system has thus been profoundly transformed, to the point where the extremely academic orientation of traditional instruction has now been sharply 'hybridized' with a highly vocational-oriented perspective. Indeed, certain observers consider that the French system is now too sharply focused on the production of qualifications specific to a given activity or occupation at the expense of high-level general education. And it is true that enrolment rates at the highest educational levels (excluding short non-tertiary programmes) lag considerably behind the countries of Northern Europe which are most committed to building a 'knowledge society'. In 2001, the figures were 37 per cent in France, 67 per cent in Sweden, and 71 per cent in Denmark.

11.3. THE CONTRIBUTION OF EDUCATION AND TRAINING TO NEW FORMS OF COMPANY ORGANIZATION AND GOVERNANCE: TOWARDS A NEW 'COORDINATED ECONOMY'

Here we focus how education, training, and the socialization of the actors interacted with two dimensions of the new forms of company regulation that emerged from the mid-1980s. The first has to do with the generating innovative changes in the area of training that favours of new forms of company organization. The second concerns corporate governance and the companies' ability to make use of banking and public resources to their advantage.

11.3.1. Professionalization of Higher Education and Organizational Changes

The general rise in training and qualification levels did not come about simply as a result of transformations within education and training. In terms of economic strategy, a clear objective was to increase the competitiveness of the French economy as a whole and more particularly industry and the large corporations. The 'professionalization' of higher education thus took place in the context of a policy of competitive restructuring of industry in 1984, and it is not by chance that this date coincides with the beginning of a sharp expansion in education and the growing vocational orientation of curricula. The in-depth restructuring of the companies, notably the largest among them including the former 'national champions', aimed at restoring company profitability through improving non-cost competitiveness. The availability of a young labour force which was better trained and more readily operational was accompanied by human resources policies which, beyond the search for external flexibility, had two major interrelated features:

– First, the privileged hiring of recent graduates, notably those with higher technician or polytechnic diplomas (BTS and DUT) at the expense of the promotion of those with the least qualifications (Béret 1992);
– And second, a restructuring of productive organization, partly based on these new career profiles (Campinos-Dubernet 1995).

Large French companies, as we know, were model examples of Fordist organization (see Storper and Salais 1997). As a result, they were confronted with the need to undertake major structural changes in their work organization. Comparative studies of France and Germany (Maurice, Sellier, and

Silvestre 1986) and France and Japan (Maurice et al. 1988) have brought out the distinctive features of the French firm: extended organizational hierarchy, compartmentalization of functions, extremely low training level of workers, including skilled workers. All of these features translate into a lack of organizational flexibility to adapt to the requirements of shortened production series, improved quality, and so on.

Two potential paths thus emerged. Either the qualifications of existing personnel had to be upgraded or the labour force had to be renewed through massive recourse to early retirement and accelerated automation. The adoption of the latter path tended to reinforce the development of qualifications and functions peripheral to manufacturing per se: quality control, production management, maintenance of new facilities, logistics, and so on. The new BTS and even DUT diplomas provided the necessary competences, sometimes at a relatively low cost given the extent of the downgrading imposed on young recruits. In spite of the difficulties of integrating graduates who were in fact waiting for higher quality jobs, the companies were thus able to carry out a considerable consolidation of managerial functions, in both the industrial and service sectors. This reorganization resulted in a double segmentation of the workforce characterized by:

(1) a highly pronounced intergenerational inequalities in levels of education and vocational training. The half of the labour force holding no diploma at the beginning of the 1980s was sidelined as quickly as possible through early retirement. After 1995, 40 per cent of the young people entering the labour market were recent higher education graduates.[8]
(2) a clear-cut hierarchy of functions and a marked split between operating personnel with few qualifications and often precarious work situations (see Beaud and Pialoux 1993) and the young technical personnel in the peripheral functions with permanent positions.

By relying on a functional reorganization made possible by the availability of middle-level (BTS-DUT) and higher-level (engineering and business schools, university masters-DESS) qualifications, French companies in a number of sectors (automobile manufacture, electrical construction, intermediate goods, the iron and steel industry, but also banking and insurance) made a forced march towards repositioning themselves in higher-quality end of product markets.

Through their ability to exploit both economies of scale and market niches, the major French companies were progressively able to compete with the emblematic firms of the CMEs (Amable and Hancké 2001). In much the same vein, a recent report by the French Council for Economic Analysis (Aghion and Cohen 2003) argues that higher education *à la française* has been effective

in supporting the development of a strategy of imitation based on incremental innovations but is not organized to support economic development on the 'technology frontier'.

11.3.2. Changing Direction in the Education System's Selection of Elites

The reorganization of the structure of qualifications is inseparable from another institutional transformation. One of the major features of the present period has been the reorientation of the system of elites from the public to private sector. A number of studies have pointed to the role of the senior branches of the French civil service coming from the elite engineering schools and the civil service college (ENA) in conducting a State-led economic policy based on their control of the larger enterprises which were nationalized in 1945 and 1981 (Suleiman 1995). Hancké (2001) shows quite clearly how the centre of gravity of this system of coordination was reoriented towards private enterprise during the 1990s. This occurred in three phases: the privatizations beginning in 1986; the break-up during the first half of the 1990s of the 'hard core' of institutional (i.e. public) shareholders which had been put in place in order to avoid takeovers by foreign capital; and finally, the massive entry of the pension funds, for the most part American, into the capital of the large firms of France's CAC-40 index (an average of 40 per cent).

In fact, the members of these elite networks enjoyed a privileged position within the three 'worlds' of finance, major industrial concerns, and State administrations. This meant that they were able to mobilize resources in the interests of a management structure which was autonomous both with regard to the State (something new) and with regard to the greatly weakened union organizations (less recent). Considerable public resources—employment incentives to speed up productive restructuring, new human resources produced by the school system, and aid from the newly created regional governments for industrial and technological development—bolstered the reorganizations carried out by this newly autonomous management.

What remains to be seen, however, is whether the growing weight of the financial markets and pension funds is not going to favour market-led rather than firm-led adjustments. The evolution of corporate governance (see Goyer 2001) probably makes France the most likely of all the CMEs to swing towards adjustments of the liberal market economy kind (see Amable and Petit 2002). Outside of the public sector, the trade unions and employee representatives in general are not in a position to oppose such changes which contrast to the prevailing situations in most of the other CMEs. In any case, this transition

will not be lacking in fits and starts, as demonstrated by the State's periodic return to centre stage in the area of company restructuring, to the great displeasure of Brussels.[9]

The construction of a new enterprise management structure is thus weakened by two factors: the ability, in the medium term, to reconcile economies of scale and industrial niches within a work organization which remains hierarchical; and the protection of corporate management from the stock market.

11.4. EXHAUSTION OR RESILIENCE OF THE INSTITUTIONAL MECHANISMS FOR PRODUCING 'COMPLEX HI-TECH ENGINEERING GOODS'?

The higher education and research system has played a determinant role in supporting a mission-oriented innovation model. It has backed up the latter's industrial successes but has also compensated for certain of its failures (e.g. computer science).

11.4.1. The Limits of a Mission-Oriented Innovation Model and its 'Colbertist' Version in France

The term 'mission' refers to technological fields which are of strategic value to the State (Ergas 1992). The main features of this model are the centralization of decision-making processes, the definition of objectives within government programmes, the large number of firms involved, and the creation of a special public agency endowed with discretionary powers to coordinate operations. The relations between science and innovation are explicitly set out and correspond to what is generally known as the 'Colbertist' model. (see Laredo and Mustar 2001). This set of arrangement sets the relations between science and innovation under the aegis of a 'higher' socio-economic entity, since scientific policy and national policy are taken to have a common objective.

The organization is based on the 'large-scale technological programme' model, in which a public agency, a higher education and research institution, and a leading industrial group (and/or several other privileged operateurs) participate, supported by a series of sub-contractors. It operates on the basis of a classical hierarchical pyramid, the prototype for which originated in the military industrial field. The objectives of the programme, the actors who participate in it, the operations to be launched and their timing are all strictly

defined a priori. This highly industrial, managerial approach with a voluntarist, modernizing bias is largely coordinated by leading corps and the elite Grandes Ecoles for engineers and by applied research centres under governmental control to which ministerial policy is directly transmitted.

Certain authors have referred to this as a 'top-down' innovation model, 'suitable for dealing with the complex technological products encountered in large public infrastructures'.[10] This kind of organizational framework has turned out to be a particularly useful one for manufacturing high technology products sold on public markets (aeronautics, space, military, nuclear, telecommunications, etc.).

11.4.1.1. A typical Case: Success in the Telecom Industry

Aspects of this framework are particular to France. There is a historic 'telecommunications circle' in France which established strong linkages between science and industry by bringing together the different players including the Ministry of Telecommunications, France Telecom (the French telephone company, recently privatized), the Centre National des Etudes en Télécommunications (National Centre for Telecommunications Research, CNET) and the three national telecommunications schools. The schools have some 2,000 engineering students as well as 400 doctoral candidates and 400 research professors distributed across a hundred laboratories. With their strong potential for combining training and research, these schools constitute a crossroad of scientific production and the dissemination of results and the success of the telecommunications industry is not unrelated to this institutional infrastructure. The historic 'telecommunications circle' has been disrupted, however, by the recent deregulation and partial privatization of France Telecom.

11.4.1.2. Information Technology: Failure in Hardware Manufacturing, Success in Services

At the various stages in the development of the IT industry, French hardware manufacturers were largely incapable, despite spurts of inventiveness, not only of translating technological advances into industrial products but even of understanding the new opportunities these advances offered.

Nevertheless, French providers of IT services have had considerable success both on the domestic and wider European markets. The argument advanced here is that a very active education policy, particularly at the higher education level, has produced a supply of valuable competences. It has to be acknowledged, though, that the hardware industry also had these same resources at

its disposal. However, the software firms were able to exploit the competitive advantage of proximity between clients and suppliers, whereas Bull was scarcely in a position to do so. Moreover, the software firms did not have to overcome the same barriers to entry as hardware manufacturers.

The sector is highly dependent upon the quality of its human resources, as is the case with the majority of services based on high-level technical knowledge. French computer engineering services firms cream off a significant share of newly qualified engineers from the Grandes Ecoles. The mutual attraction established between these firms and the 'best engineers' is certainly one of the strengths of the French IT services sector. Besides, the French higher education system has been able to increase its supply of computer engineers without compromising the quality of its training. The entire French economy has thus benefited from the production of increasingly well-trained IT professionals. As a result, mobilizing societal resources produced by the education system has produced some very positive effects. For example, certain French software firms excel in scientific calculation or the production of state-of-the-art software because of their proximity to the aerospace and nuclear industries.

While French companies in the computer services sector have managed to defend their domestic market and capture positions of strength on the international consulting market, they have not been able to do the same in the area of standardized software development. This is an activity which arguably demands a high level of risk-taking for technological breakthroughs (radical innovation) of the sort typically generated by small-size start-ups which are 'guided by "high-powered" market incentives' (Casper, Lehrer, and Soskice 1999).

11.4.2. Inability to Develop a Diffusion-Oriented Innovation Model: A Failure of the Higher Education System

The reasons for this failure are multiple. Some bear no direct relationship with higher education per se, such as the shortage of venture capital or the extreme scarcity of business angels, the excessive polarization of public funding for research in mission-oriented sectors, the inefficiency of aid schemes for the SMEs, and the lack of incentives for researchers to develop their knowledge in the private sector (for a critical analysis see Branciard and Verdier 2003).

We focus here on those factors more explicitly connected to the higher education system in order to explain the difficulty public policies have encountered in encouraging the emergence of a diffusion-oriented

innovation model.[11] These overlap once again with the conclusions of the Aghion-Cohen report (2004), intended to explain the difficulty of 'French-style' public institutions and organizations to promote entry into a system producing radical innovations through competitiveness at the 'technology frontier' and not simply through a strategy of incremental innovation. AQ1

11.4.2.1. Ph.D. Theses: Increased Numbers and Uncertainty

Training through research, although recognized in all the industrialized countries, 'still has to acquire its letters of nobility in France' (Cohen and Le Déaut 1999). This expression, close to that of 'academic nobility' dear to Pierre Bourdieu, is a good indication of the distance that remains to be covered in facts and mindset alike.

Between 1992 and 1997, the overall number of theses completed rose by 29 per cent, with particularly sharp increases in the social sciences (+45 per cent) and large disparities among physical and life sciences: stagnation in chemistry (+1 per cent); a slight increase in fundamental biology (+9 per cent); a veritable explosion in 'applied biology/ecology' (+67 per cent); and a considerable increase in engineering (+31 per cent); and in physics (+30 per cent) (see OST 2000).[12]

The growth of doctoral studies stems not only from the overall expansion of higher education but also from public intervention which has done its best to increase the possibilities for thesis funding, job openings in the academic arena, and the bonus for dissertation and research supervision (Cohen and Le Déaut 1999). The rates of funding through grants (private and public, excluding salaried doctoral students) are high in the 'hard' sciences, ranging from 72.8 per cent in applied biology or ecology to 89.5 per cent in physics, with an average of 63.2 per cent, as compared to 24.6 per cent in the social sciences.

Overall, the examination of labour market entry conditions for Ph.D.s shows that 'the path of training through research does not [yet] seem to be totally recognised in France' (Bourdon 1999). The majority of Ph.D.s still enter the public sector (62 per cent in 2004) and primarily on public research and higher education (47 per cent). Furthermore, 'among youth from the 1994 cohort holding an in-company research post in March 1997, only 8.7 per cent held purely academic Ph.D.s. Fully 63.7 per cent held an engineering school diploma, 23.6 per cent a lesser university diploma, and 3.7 per cent an engineering Ph.D.s (see Beltramo, Paul, and Perret 1999). In the business world, the societal image of the engineer trained in a specialized school still dominates recruitment to the R&D function (see Lanciano and Nohara, this volume). In the large companies, the title of engineer opens possibilities for

internal mobility towards other functions which are less accessible to purely academic Ph.D.s. This encourages a model of innovation based on a, 'high degree of human circulation and hybridisation of knowledge between research activities and the other functions' (Béret 2000) which favours incremental innovation.

Along with the ever-present weight of the Grandes Ecoles–universities divide, these features show the limits of political voluntarism in the area, as the authors of the parliamentary mission on research priorities implicitly recognize: 'The research sector, for reasons of French company culture, recruits less than 20 percent of the PhDs trained in our universities. ... It is clear that concrete proposals for increasing the recruitment of PhDs in the private sector are indispensable, (Cohen and Le Déaut 1999).

Structural difficulties in channelling Ph.D.s, and all those having advanced graduate studies, towards the companies help to explain why the number of researchers per inhabitant is relatively low in France. If this ratio is comparable to that found in Germany and the UK, it is considerably lower than that in the USA and Japan in spite of a sharp increase during the 1980s (from 3.6 per thousand in 1981 to 6 per thousand in 1998). But above all—and this is our main point—it must be stressed that the relative presence of in-company researchers in France is the lowest of all the industrialized countries with the exception of Spain and Italy.

11.4.2.2. The Ambiguity of Post-Docs: Job Queue or Career Path?

Post-docs have been enjoying a rapid increase. Among those awarded a Ph.D. in 2001, 31 per cent held post-doctoral fellowships after the defence of their theses, against 21.7 per cent in 1996, with the proportion varying between 9 per cent for those in social sciences to more than 47 per cent in biology, medicine, and health (Giret 2005). The double bind of the drop in the number of academic jobs offered to Ph.D.s between 1993 and 1997 and the sharp increase in the number of theses completed, 'has amplified the gap between the number of Ph.D.s and the number of researcher or lecturer posts. This has created the phenomenon of the job queue; many candidates who are unsuccessful in recruitment examinations for getting a job in the public sector decide to do a post-doc while waiting to reapply the next year with a more solid CV' (Cohen and Le Déaut 1999). The fact that this segment of the labour market is 'societally' dominated by young engineers coming from the Grandes Ecoles makes reorientation towards the private sector all the more uncertain (Lanciano and Nohara, this volume).

This situation makes the stabilization of another, more research-orientated model for the labour market entry of Ph.D.s even more crucial: the start-ups,

as incarnated in the SMEs, which allocate relatively more money to basic research (Béret 2000). Characterized by more intensive external mobility, as well as by a greater representation of Ph.D.s and those holding foreign diplomas, these small-scale companies constitute a domain of innovation which, though just beginning to emerge, is of strategic importance for the future. Certain complementary resources in initial or continuing training might well bolster the creation of these new all too rare enterprises at this stage.

11.4.2.3. A (Diminishing?) Lag in Entrepreneurship Training

Business start-ups do not depend solely on the quality of the knowledge produced by fundamental research. It is also necessary to have access to the relevant competences in order to respond to customers and face up to competitors in new markets which often remain to be invented. However, 'if the French educational system produces large cohorts of science graduates, it does not sufficiently push the young talents towards entrepreneurial careers, in accordance with a scale of values forged by a history which, in this century, has reserved an exceptional role for State entrepreneurship' (OECD 1999: 135). AQ2

This approach is reflected in the overall diagnosis of French higher education, which is said to, 'train employees more than it cultivates entrepreneurial talents' (Guillaume 1998), as demonstrated by the limited opportunities for training in entrepreneurship or SME management. Nonetheless, since 1995 there has been a clear trend towards the creation of such training programmes (15 in 1995, 155 in late 1998, plus 75 in the planning stage). This is, 'making entrepreneurship a recognised academic discipline, as in the United States' (Stéphane Marion, professor at the Ecole de Management in Lyons, cited by Reverchon 1999). Such an effort brings into play the forms of regulation and organization of higher-education structures which, in France, do not easily recognize new disciplines, especially when they come from the business world. Indeed, the difficulties of organizing public action in favour of innovation manifest themselves most clearly in relation to SMEs.

11.4.2.4. Organizational Complexity, Undersized Higher Education Institutions

The Balkanization of higher education in France is even more extreme than is the case for research. In addition to the 81 public universities with a population of 1,300,000 young people (excluding the polytechnics) there is a constellation of 238 engineering schools and 230 business schools which

receive some 142,000 students by selection (Attali 1998). The Attali Report speaks of 'Gulliver tied up in knots' to characterize the higher education system. An often inefficient 'government of the universities' is caught between a ministerial supervision, which is much more extensive than the autonomy (partially formal) accorded the university presidents, and the feudalism of the training and research units, heirs of the old schools, which resist participation in any global policy for the institution. This is especially true because behind the national standardization of university rules and diplomas, 'an implicit hierarchy of universities has emerged. ... Their size and their means vary considerably from one university to another' (Cohen and Le Déhaut). And in the name of the excellence of their training profiles, a number of the Grandes Ecoles jealously exercise their individual prerogatives, which only accentuates the Balkanization of the system, while it is far from certain that in the future these schools will have the necessary critical mass, notably in the area of research. The system as a whole is difficult to comprehend and is resistant to reform.

In this context, the evaluation of the universities by the present National Evaluation Committee clearly constitutes an advance in relation to a past characterized by the absence of any institutional mechanism for assessing higher education establishments. However, 'it is neither fast enough nor transparent enough. In general, it is not followed by any budget decision or reform. For the time being, it succeeds only in helping the universities to prepare for their own internal monitoring' (Attali 1998).

More generally, the evaluation of programmes, procedures, and institutions does not seem to be as reliable as the stakes would demand. It is supposed to lead to the elaboration of recommendations for the heads of the programmes or institutions, as well as the authorities requesting it. In fact, it must be recognized that the main concern is not to destabilize the 'scientific government' in place (Attali 1998: 19). It is not at all clear that such a structure is capable of facing up to the pressures of global competition in the field of research and education, which is all the more formidable given the spread of long distance education via the Internet.

11.4.3. The Development of Local Cooperative Relationships Between Industry and Research: An Opportunity for local resiliency?

Another paradox of the French situation has to do with the fact that the resources most important for going beyond the 'technology frontier' have emerged in part as the unanticipated result of major technology programmes of the past. ICTs and now nanotechnologies provide convincing examples.

The system of cooperation between industry and research in the French IT industry continues to be modelled in large part on a past policy of the French state for promoting large-scale scientific programmes (see Nohara and Verdier 2001).[13] As the case of the Plan-Calcul illustrates at the end of the 1960s, major scientific and industrial programmes have been implemented by public establishments with a large degree of financial autonomy. Centralization of technological innovation has gone hand in hand with a preoccupation with national and regional development, which has led the State to intervene by making financial contributions to regional economic development and installing scientific and technical infrastructures.

As far as the IT industry is concerned, the Plan-Calcul and the various national programmes designed to boost the electronics industry have contributed to the development of certain regional technological centres, in part through the choices made in the location of public sector research establishments (CNRS, INRIA, etc.), in part through the expansion of the engineering schools and to some degree through the establishment of research facilities by public and private companies with high scientific potential (CEA, the atomic agency, CNET—in telecommunications, etc.).

Apart from the Greater Paris region (Ile-de-France), which accounts for fully half of the national R&D capacity, there are four other dynamic regional centres for electronic technologies with a high IT component.

By far the most important centre outside Paris is the Grenoble region. Often dubbed the French 'Silicon Valley', this area occupies first place in the European league table for microelectronic research. In particular, the semiconductor industry benefits from synergies based on a close link between research and production. This region accounts for 10 per cent of national expenditure on R&D in electronics. The region has a strong university tradition, which acts as a catalyst for cooperation between public sector research establishments and engineering schools and companies, including both large groups (Bull, Hewlett-Packard, Thomson, Cap-Gemini, etc.) and small- and medium-sized firms. The latter produce hard disc reading heads, are engaged in optoelectronics, produce software packages for structural calculation, and develop software validation tools (case of an INRIA spin-off). With the support of national and regional public agencies and bodies, this district is now becoming a major player in nanotechnologies: the main private stakeholders are FMN, European players like ST Microelectronics, or American ones like Motorola.

The second centre is constituted around Motorola and IT firms linked to the aerospace/space industry in the Toulouse region. This concentration was explicitly created through national policies in aerospace, space sciences, and electronics, namely the decentralization of the CNES (National Centre for

Space Science), the location of Airbus-Industrie, and the arrival of Motorola within the framework of the Plan-Calcul. This productive infrastructure is fed by flows of engineers trained by engineering schools such as the Ecole Nationale Supérieure de l'Aéronautique as well as scientific universities. The third centre, in the Brittany region, is organized around digital telecommunications technology (IT, telecommunications, and networks). The fourth centre, Sophia-Antipolis in the Nice region, was one of the first prototypes of the now-familiar science park (Longhi 1999).

In this kind of institutional configuration, the State is no longer acting on its own behalf in pursuit of 'royal' objectives determined from above, but rather, permits local action to move towards the realization of a common good (Salais 1998).

According to this model, the future site of the coproduction of knowledge lies at the intersection between three interacting institutional spheres, the university and the research organizations, industry, and the public authorities.

This attempt to create bridges between academic research structures and industry by integrating the knowledge-generating infrastructures into the innovation-producing systems might lead to the existence of three-part networks reflecting the involvement of these three kinds of institutional spheres, and to the emergence of hybrid organizations at the interfaces between the three (Etzkowitz and Leydersdorf 2000). The aim of the bridging schemes is to create an environment propitious to innovation including spin-offs originating from the universities and to produce research sites at which to launch economically stimulating multiple initiatives based on scientific knowledge, strategic alliances between firms of various sizes working at various technological levels, public research laboratoires, and groups of university research workers. In encouraging the implantation of R&D structures bridging the traditional frontiers between institutions (the public–private sector, academic or applied research, etc.) and founding scientific and industrial parks at the local level, these public interventions subscribe to the organized accumulation of knowledge and the creation of innovative skills at the micro-, méso-, and macroeconomic levels combined.

11.5. CONCLUSION

In the context of the 'knowledge society' paradigm, the paradoxes and tensions observed in the evolution of the French higher education and research system are instructive for an appreciation of the impact and limits

of public action in this area. As we have seen, the rapid increase in enrolment rates during the 1988–98 period was accompanied by a very clear 'vocationalization' of curricula. This was particularly true in higher education, which made a significant effort to develop a system of higher technological education recognized and appreciated by industry. These educational resources were mobilized for an in-depth productive reorganization, notably in the large industrial concerns but also in the financial sector. This reorganization was carried out by the elite traditionally coming from the Grandes Ecoles, especially those producing the senior branches of the civil service. What distinguishes this phase of the restructuring, as Hancké (2002) has clearly shown, is the managerial elite's growing autonomy in relation to the State. This has ensured the return of France's major firms to industrial competitiveness and high profitability. Nonetheless, such an 'economy coordinated by an elite network' seems fragile in so far as it is challenged by the firms of other coordinated economies which can rely on compromises reached with labour.

These questions are all the more vital in face of serious doubts about the ability of vast technological programmes to renew a capacity for innovation on the 'technology frontier'. This was achieved in the past through a mission-oriented innovation policy centred on hi-tech goods and largely realized within the framework of State markets. As the telecommunications example shows, this model relied heavily on the excellence of the elite engineering schools and specialized public research centres. This institutional configuration, however, does not respond as efficiently to the demands of the 'diffusion-oriented' model.

From this standpoint, the French experience, in spite of the considerable expansion of its higher education system, reveals an inadequacy and a tension. Entrepreneurship training, notably in order to develop knowledge and create hi-tech start-ups, seems largely inadequate; training through research is not really recognized in the private sector, which is reluctant to hire Ph.D.s to man R&D teams if the thesis is not combined with an engineering diploma from a Grande Ecole. In addition, masters level vocational training programmes tend to attract the best university students and thus to divert them from training through research. As a result, the base of knowledge and competences produced by the higher education and research system seems much too narrow for a diffusion-oriented innovation model. If the recruitment pool for the top levels of higher education at the highest levels is not considerably broadened, the tension between a policy of vocational-oriented training and one valuing career paths based on training through research will only be reinforced. In some way, this might give rise to a tension between the 'learning industry' *à la française*, an unquestionable success of the vocationalization of studies as attested by the emergence of a new form of

coordinated economy, and the 'knowledge society' which is struggling to achieve social legitimacy.

One irony of this history, however, is the emergence of highly dynamic technology parks which are spin-offs of the heyday of the great technological programmes and notably of one of the most flagrant industrial failures, the Plan-Calcul which was intended to stimulate a national computer industry. The new forms of public policy likely to support the growth of these technology parks and promote the creation of others remain to be invented.

NOTES

1. These distinctions recall the typologies of the French Regulation School (Boyer 2002), which identifies four forms of capitalism which are 'dominant financial market, meso-corporate, social-democratic, and State-driven'.
2. See Postel-Vinay (2002) who, in the area of research, advocates adoption of the American model pure and simple.
3. These two structures train technicians within a two-year programme. Diploma-holders may then enter working life or opt to continue their studies in another programme (university, sometimes engineering school).
4. It should be pointed out, however, that the internal regulation of the university system gives strong impetus in this direction. Thus, the Higher Education Division, which has been negotiating four-year contracts with the universities since the mid-1980s to develop the overall map of the programmes offered, encourages them to develop vocationally-oriented training.
5. The Brevet de technician supérieur (BTS) and the Diplôme universitaire de technologie (DUT) are two-year post-*baccalauréat* higher technician training programmes for industry.
6. In 1998, the social sciences accounted for 60 per cent of the total number of students.
7. For further details, see Martinelli and Molinari 2000.
8. In terms of early retirement, France has the lowest rate of labour-force participation for the 55–60 age group among all OECD countries.
9. It was indeed under the aegis of a government defending liberal economic policies that the State intervened in 2003–4 to maintain the autonomy of the French management of major groups: the Aventis–Sanofi merger in favour of a French board of directors, the defence of GEC-Alstom against the risks of industrial break-up and takeover by German competitors, and so on.
10. R. Barré and P. Papon, 'La compétitivité technologique de la France', in Guillaume, Henri 1998, *Rapport de mission sur la technologie et l'innovation*, submitted to the Ministry for National Education, Research and Technology, the Ministry of

Economy, Finance and Industry, and the Secretary of State for Industry, Paris, 216–27, 1998.

11. Such a policy is characterized by its decentralized nature. The role of public bodies is limited and the accent is placed on the association of cooperative forms of research and institutions promoting the systematic dissemination of scientific knowledge and technology. Innovations emerge locally on the basis of researcher–entrepreneur initiatives supported by multiple partnerships.
12. In 2002, 17 per cent of Ph.D. theses were completed in social sciences, 14 per cent in engineering, 10 per cent in mathematics, 10 per cent in chemistry, 5 per cent in fundamental biology, 5 per cent in applied biology/ecology ...
13. This paper inspires the following paragraphs.

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